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## Diurnal rhythms and seasonal changes in the roosting behaviour of Indian myna *Acridotheres tristis* (Linnaeus)

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**Abstract.** The present study deals with the awakening and roosting behaviour of mynas. In the annual cycle of these mynas, 3 distinct phases were noticed—the pre-breeding season (November–March), breeding season (April–July) and post-breeding season (August–October). The various roosting activities of mynas such as the time of waking up and calls, the time of arrival and departure of the first bird and up to the last bird, communal noise and the time of final settlement at the communal roost show a systematic diurnal and seasonal changes in relation to the times of sunset and sunrise (i.e. the light and dark periods of a 24 h day). These changes were found to be consistent at all the roosts under observations and during all the years of the study. These changes seem to be governed by endogenous rhythms, which are slightly altered due to the endocrine secretions particularly in the breeding season and are also modified due to the adverse climatic conditions.

**Keywords.** Diurnal rhythms; seasonal changes; roosting; bird behaviours; Indian myna; *Acridotheres tristis*.

### 1. Introduction

Studies on roosting behaviour of birds have constituted a popular subject in ornithological research in the world for many years. Such studies on roosting behaviour of Indian mynas have been reported by some workers in India and in other countries (Hindwood 1948; Gadgil 1972; Counsilman 1974; Feare 1976; Greig-Smith 1982; Sengupta 1982). Indian myna *Acridotheres tristis* (Linnaeus) Sturnidae: Passeriformes is a familiar urbanised bird distributed over the entire Indian sub-continent. Mynas are sociable in their habits. They are generally seen in pairs or in small flocks during daytime. In all the seasons, they roost communally at night in groups of 100–10,000 birds, either independently or forming a mixed roost alongwith some other species of birds.

Apart from the detailed study by Counsilman (1974) there is very little information on awakening and roosting behaviour of Indian mynas. We present in this paper the results of our observations on the various aspects of roosting behaviour of Indian mynas at Pune.

### 2. Materials and methods

Altogether 19 communal roosts located in Pune (18° 30' N and 73° 53' E) were censused at various times during June 1973 to July 1981. These roosts were designated by definite numbers R-I to R-XIX for the convenience of recording the observations.



## 2.1 Roosting behaviour

At all these roosts, observations on the time of arrival of the first bird in the evening and that of all the successively arriving birds up to the last bird, movements near the roost and the time of final settlement at the roost were recorded. These observations were carried out once in each month from June 1973 to August 1976 at each roost during successive 5 min interval, roughly between 1645 and 1930 h.

The observations on the time of awakening, movements near the roost and the time of departure of the first bird and of all the successively departing birds up to the last bird were made in the morning during successive 5 min interval roughly between 0500 and 0730 h. These observations were carried out fortnightly at two communal roosts for a fixed period as follows: at R-IV from August 1975 to September 1976 and at roost R-III from October 1975 to September 1976.

These pre-roosting and post-roosting behavioural observations were repeated for confirmation at roost R-IV during August 1980–July 1981.

## 3. Results

During the study period at all the 19 roosts, the mynas have roosted in close proximity with human settlement on trees in all the seasons. The following 3 phases were observed in the annual cycle of Indian mynas—the pre-breeding season (November–March), breeding season (April–July) and post-breeding season (August–October).

### 3.1 Awakening and departure activity

After a period of rest, mynas slowly wake up in the morning. Generally, waking of mynas starts about 40–50 min before sunrise. At first, only a single myna (and occasionally two mynas) wake up and emits a low-pitched call (beginning of noise). After this first call, there is silence for about 2 to 3 min. Once again there is a call followed by silence for about 1 to 2 min. The call continues. This sequence is repeated till the silent period is reduced to only a few seconds. Within a short time of 10–15 min most of the mynas thus wake up and begin to make the loud communal noise. While making the communal noise, mynas undertake certain movements at the roosting trees such as hopping, jumping between the branches and pushing each other. As the noise increases these movements also increase. This noise continues for another 15–20 min after which it slowly decreases as the mynas gradually leave the roost.

Figure 1 indicates the monthly and seasonal changes in the awakening and departing activities of mynas at roost R-IV during 1975–76. Throughout the post-breeding season from August–October, the time of sunrise occurs successively later. In the pre-breeding season also it occurs successively later from November–January and then successively earlier till March. In the breeding season, the time of sunrise occurs successively earlier from April–June and then later in July. In all these seasons, the waking of the first myna (beginning of noise) was found to be changing according to the time of sunrise. In the month of May (breeding season), waking up of the first bird was earliest (67 min before sunrise) as compared to other months of the year. The time taken for awakening (i.e. the time interval between the beginning



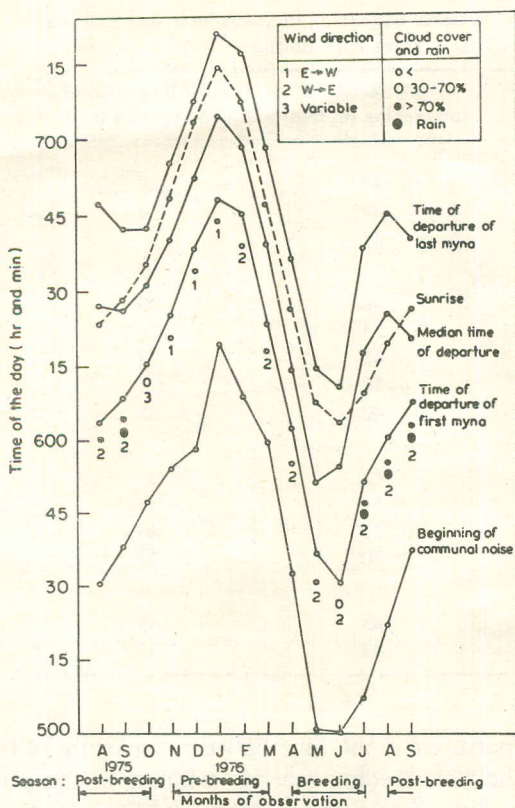


Figure 1. Monthly and seasonal changes in the time of awakening behaviour of mynas at roost R-IV during 1975-76.

of noise and median time of departure) of mynas at the roost was calculated, which shows monthly and seasonal variations (table 1).

The time of departure of the first and the last myna changes according to the time of sunrise in all the seasons. The time of departure of the first and the last myna was always before and after the time of sunrise respectively. The duration between the time of sunrise and that of departure of the first and the last myna was however not constant, but showed seasonal variations. In the month of June, the time of departure of the first myna from the roost was the earliest (33 min before sunrise) and in the month of July, it was much later (18 min before sunrise). Similarly, in the month of December, the time of departure of last myna from the roost was earliest (4 min after sunrise) and in the month of July it was much later (29 min after sunrise).

The seasonal changes in the median time of departure of mynas (i.e. the time at which 50% of the total population of mynas have departed from the roost) were consistent with the changes in the time of sunrise. The median time of departure of mynas was before sunrise except in the months of August 1975, July and August 1976, during which it occurred 4, 8 and 6 min after sunrise respectively. In the month of May, the median time of departure was the earliest (16 min before sunrise) as compared to other months of the year.

**Table 1.** Monthly and seasonal changes in the awakening time and time span of departure of mynas at roost R-IV during 1975-76.

Season	Time taken for awakening (in min)	Total time span of departure (in min)
Post-breeding		
August (1975)	57	44
September	48	34
October	44	27
Pre-breeding		
November	46	30
December	54	29
January (1976)	45	33
February	50	32
March	40	35
Breeding		
April	42	34
May	51	38
June	55	40
July	70	47
Post-breeding		
August	63	45
September	43	33

The total time span of departure (i.e. the time between departure of the first and the last bird) was less in the pre-breeding season, medium in the post-breeding season and more in the breeding season. In the month of October the total time span of departure was lowest (27 min) and in the month of July it was maximum (47 min) as compared to other months of the year (table 1).

The time of departure in relation to time of sunrise and the number of mynas leaving the roost at R-IV has been indicated for each of the 3 seasons in figure 2. This figure shows that in the pre-breeding and breeding seasons more than 90% of the total population of mynas left the communal roost before sunrise. However, in July (end of the breeding season) and in August (beginning of the post-breeding season) only about 20-40% mynas left the roost before sunrise.

After leaving the roosting trees in the morning, mynas take to certain temporary halting places (trees, ground, etc.) near the roost before dispersing into feeding arena. Some differences were noticed in such movements of departing mynas in different seasons. It was observed that towards the end of post-breeding season, mynas started giving more preference to halt on ground and less preference to halt on trees after leaving the roost. This preference of coming down to ground gradually increased till the middle of the pre-breeding season. Thereafter, they gave less and less preference to halt on the ground in the breeding season and this continued till the beginning of the post-breeding season. Exactly reverse situation was noticed with respect to preference to halt on the trees.

### 3.2 *Arrival activity*

In the morning, mynas disperse into the feeding arena and spend the daytime in various activities such as feeding, nesting, making communication calls, resting and



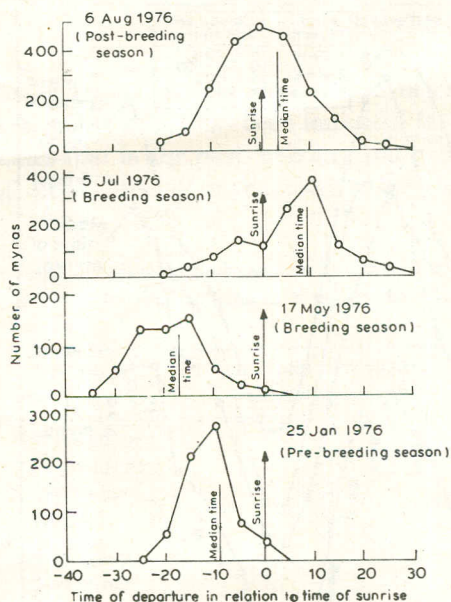


Figure 2. Seasonal variation in number of mynas departing before and after sunrise at roost R-IV.

preening. In the evening, mynas slowly start their return journey towards the communal roost. When they arrive at the roost, some of the mynas fly directly into the roosting trees. However, a majority of them take to certain temporary halting places (such as other trees, bushes, ground, etc.) in the immediate vicinity of the roost, before flying into roosting trees. A detailed study of these movements was undertaken at roost R-III between June 1973 and July 1974. It was found that the proportion of the above two categories of movements of arriving mynas varied from season to season. In the breeding season 37% mynas arrived at the roost from the feeding ground flew directly into the roosting trees. This number successively declined in the post-breeding and the pre-breeding seasons to 29 and 10% respectively.

It was observed that almost all the flocks of mynas made a big noise in the breeding season and till the middle of the post-breeding season while arriving in the vicinity of the roost. Thereafter, the number of flocks making noise was found to be decreasing and it was minimum in the pre-breeding season. This seasonal difference coincides with the noise made by mynas while departing from the roost in the morning.

The arrival activity of mynas was recorded at each communal roost in the evening during the entire study period. Figure 3 indicates the monthly and seasonal changes in the arrival activity of mynas during the year 1973-74. Throughout the post-breeding season from August to October, the time of sunset occurs successively earlier. In the pre-breeding season, it also occurs successively earlier till December and then successively later from January-March. In the breeding season, the time of sunset occurs successively later from April-June and then earlier in the month of July.

The time of arrival of the first and the last myna changes according to the time of

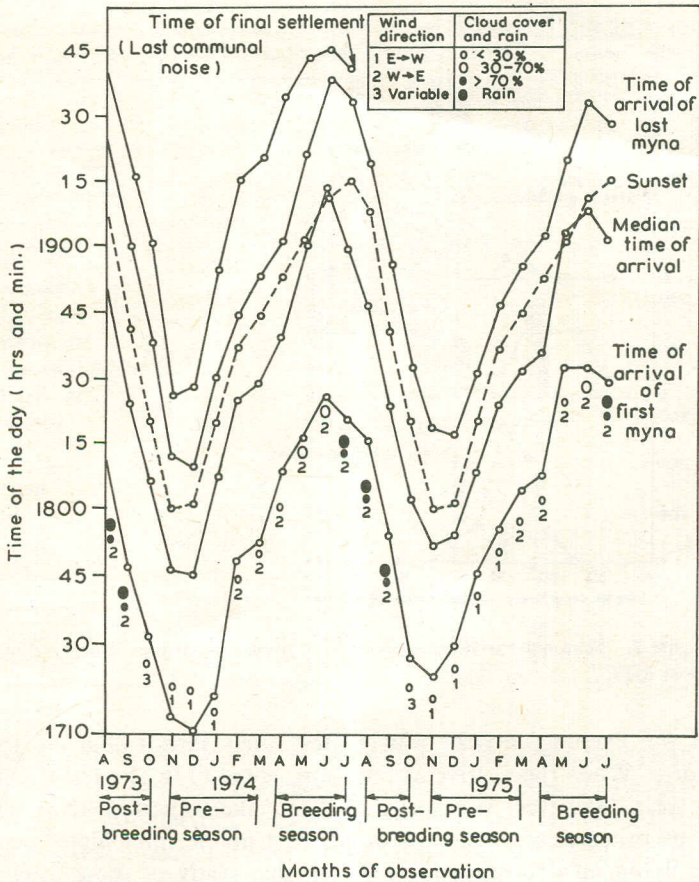


Figure 3. Monthly and seasonal changes in the time of arrival and final settlement of mynas during two successive years (mean of all roosts).

sunset in all the seasons. The time of arrival of the first and the last myna was always before and after the time of sunset respectively. The duration between the time of sunset and that of arrival of the first and the last myna was not constant, and showed seasonal variations. In the month of August 1973, the time of arrival of the first myna at the roost was the earliest (59 min before sunset) and in the month of April 1974 it was much later (44 min before sunset). Similarly, in the month of February 1974, the time of arrival of the last myna was found to be during sunset period (7 min after sunset) and it was much later (27 min after sunset) in June 1974, as compared to other months of the years 1973–74.

The seasonal changes in the median time of arrival of mynas (i.e. the time at which 50% of the total population of mynas have arrived at the roost) were almost consistent with the changes in the time of sunset. The median time of arrival of mynas was always before sunset except in the month of June 1974 during which it occurred later (2 min after sunset). In the month of August 1973 the median time of arrival was the earliest (19 min before sunset) as compared to other months of the year 1973–74.

The total time span of arrival (i.e. the time between arrival of the first and the last bird) was less in the pre-breeding season, medium in the breeding season and more

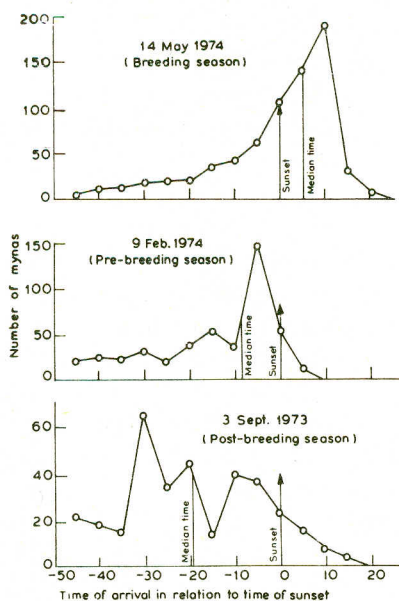


in the post-breeding season and it was maximum (75 min) in the month of July 1974 (table 2).

The time of arrival in relation to time of sunset and the number of mynas arriving at the roost R-VII has been indicated for each of 3 seasons in figure 4. This figure indicates that in the post-breeding and pre-breeding seasons more than 85% of the total population of mynas arrived at the communal roost before sunset.

**Table 2.** Monthly and seasonal changes in the time span of arrival and time for final settlement of mynas during 1973-74. (mean of all roosts).

Season	Total time span of arrival (in min)	Time taken for final settlement (in min)
Post-breeding		
August (1973)	74	48
September	73	52
October	68	54
Pre-breeding		
November	58	40
December	59	44
January (1974)	69	50
February	56	52
March	61	53
Breeding		
April	53	55
May	66	45
June	73	32
July	75	44



**Figure 4.** Seasonal variations in number of mynas arriving before and after sunset at roost R-VII.



However, during May (middle of the breeding season) only about 32% mynas arrived at the roost before sunset.

### 3.3 *Final settlement and communal sleep*

After arriving at the communal roost, mynas start making a low pitched noise. As more and more mynas join the roost, the noise gradually increases. Simultaneously, they undertake certain movements at the roosting trees such as hopping, jumping between the branches and pushing each other. When more than 50% of the mynas have joined the roost, such movements and also the communal noise reach the peak. This communal noise in the evening was much louder than that made in the morning before departing from the roost. At intervals, they suddenly stop making the communal noise and also the movements for few seconds. After this pause, they again continue to make the noise and movements. This sequence was repeated 5 to 6 times and the pause between these activities increases gradually. Finally, these activities stop altogether about 25–45 min after sunset, when mynas settled down at the roost and retire for the communal night's sleep or rest.

The time of last communal noise (time of final settlement) made by mynas was recorded at each communal roost late in the evening and it was found to be consistent with the changes in the time of sunset in all the seasons (figure 3). The time of last communal noise was earliest (26 min after sunset) in the month of November 1973 and it was much later (42 min after sunset) in the month of April and May 1974 as compared to other months of the year 1973–74. The time taken for final settlement (i.e. the time interval between the median time of arrival and the last communal noise) of mynas at the roost was calculated for the year 1973–74 which shows monthly and seasonal variations (table 2).

During the communal sleep at night, mynas occasionally wake up because of some known as well as unknown reasons. In few instances, they were found to be disturbed by an approaching owl (a bird of prey) and flying fox (a harmless mammal). After this temporary commotion, they again made the usual communal noise and the peculiar movements (described earlier) at the roost, before resuming their communal sleep. The night break-up was observed in every month of the year.

### 3.4 *Time spent at and outside the communal roost*

The total time spent at the communal roost (that is, the time interval between the median time of arrival of mynas in the evening and the median time of their departure in the morning) and the time spent outside the roost in the feeding arena during a 24 h day were estimated on the basis of departure and arrival activities of mynas at all roosts during the year 1975–76 (figure 5). The figure indicates that the proportion of time spent at and outside the communal roost changes monthly and seasonally. Generally, the time spent outside the roost was more or less the same ( $\pm 7$  min) as the actual daytime period available between sunrise and sunset. The only exceptions were the months of July and August, when they spent 21 and 35 min less respectively in the feeding arena than the actual available daytime period. In the month of December (in the pre-breeding season), mynas spent maximum time (783 min) at the roost and minimum time (657 min) outside the roost. The reverse was the case in the month of June (in the breeding season), when

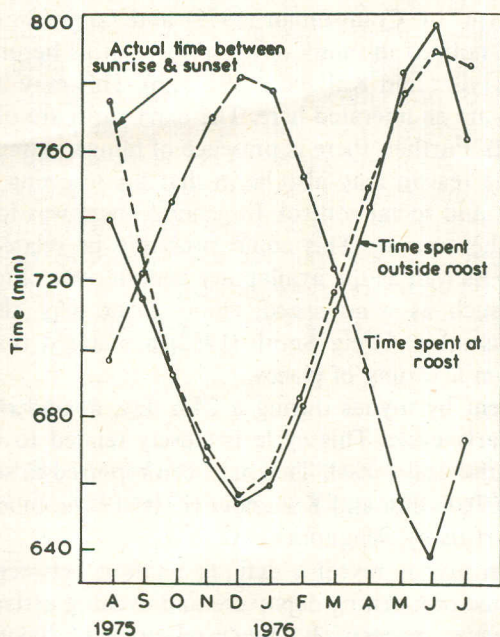


Figure 5. Time spent by mynas at and outside the roost during different months of 1975-76.

they spent minimum time (640 min) at the roost and maximum time (800 min) outside the roost.

### 3.5 Confirmation of above observations in other years

The observations carried out on the awakening and departure activities of mynas from the roost in the morning were also simultaneously studied at roost R-III during 1975-76. The monthly and seasonal changes were found to be identical to those at roost R-IV (figure 1). The observations carried out on the arrival activities of mynas at the roost in the evening were also studied further for two subsequent years, viz. 1974-75 (figure 3) and 1975-76. The pattern of monthly and seasonal changes were found to be substantially similar to the changes described for 1973-74 (figure 3). All the above morning and evening post- and pre-roosting behavioural observations were repeated at roost R-IV during August 1980-July 1981. It was confirmed that similar diurnal and seasonal trends exist in the roosting activities of mynas from year to year.

## 4. Discussion

Our studies clearly show that there are diurnal rhythms and seasonal changes in the awakening and roosting activities of mynas. These are influenced by environmental, physiological and behavioural factors.

Throughout the year, the morning departure (roost break-up) of mynas was shorter as compared to their evening arrival (assembly). This confirms the earlier



observation on the Indian myna by Counsilman (1974) and Greig-Smith (1982). Such behaviour has also been noticed in many other birds such as herons (Seibert 1951), starlings and magpies (Gyllin and Källander 1977a, b). This may be because of several facts, some of which are enumerated here. The departures are observed at their origin (Greig-Smith 1982). Further, there is presence of hunger stimulus in the morning (Swingland 1976). The reason may also lie in that the morning departure activity is under internal clock and social control. In general, there was longer time span of arrival of mynas in the evening. This could probably be related to their dispersion in the feeding arena as well as the availability and amount of food in the arena. Some abiotic factors such as wind speed, cloud cover may also be the reasons for longer time for assembly. Greig-Smith (1982) has stated that arrivals represent the end of flights from a variety of places.

The distribution of time spent by mynas during a 24 h day, at and outside the communal roost shows an yearly cycle. This cycle is closely related to the actual daytime available between sunrise and sunset. This has been reported in some other birds by Naik and Razack (1967); Gyllin and Källander (1976, 1977a, b) and also in common mynas *Acridotheres tristis* by Sengupta (1982).

The present observations on mynas reveal a definite relation between monthly and seasonal changes in the time of morning departure and evening arrival and the time of local sunrise and sunset respectively. Such relationship has also been pointed out in other birds by various workers; in house swift *Apus affinis* (Naik and Razack 1967), blue magpie *Cyanopica cyana* (Hosono 1967), cattle egret *Ardeola ibis* (Siegfried 1971), jackdaw *Corvus monedula* (Tast and Rassi 1973; Gyllin and Källander 1976), starling *Sturnus vulgaris* (Gyllin and Källander 1977a), magpie *Pica pica* (Gyllin and Källander 1977b) and also in common myna *Acridotheres tristis* (Counsilman 1974; Sengupta 1982).

The actual physical stimulus influencing the roosting activities in Indian mynas and in many other birds during the sunrise-sunset cycle may be that of light intensity. This has been reported by number of workers—see reviews of Siegfried (1971) and Counsilman (1974) as also contributions of Razack and Naik (1965); Hosono (1973); Tast and Rassi (1973); Daan (1976) and Swingland (1976). Aschoff (1967) has focussed attention on the fact that changing environmental condition alone do not cause the rhythmic changes from wakefulness to sleep, and that an endogenous rhythm is also present.

This endogenous activity rhythm is found to be slightly altered seasonally. Hormonal secretions in the body may bring about changes in several activities of mynas in the breeding season, particularly in the months of May and June. In these months, mynas behave differently. This view is supported by experimental evidence of Chaturvedi and Thapliyal (1980), who found that in common mynas *Acridotheres tristis* the adrenals and gonads were maximally active during May–June and were relatively inactive during the following months. Counsilman (1974) has also stated that during breeding season, when reproductive hormones of Indian mynas are most effective, they behave differently.

The endogenous activity rhythm is also slightly modified due to adverse climatic conditions such as heavy cloud cover and rains; particularly observed in the months of July–August. These climatic changes make most of the mynas to leave the roost after the time of sunrise and return to roost well before sunset. In many other birds such as blue magpie *Cyanopica cyana* (Hosono 1973), jackdaw *Corvus monedula*



(Tast and Rassi 1973; Gyllin and Källander 1976), starling *Sturnus vulgaris* (Gyllin and Källander 1977a), corn bunting *Emberiza calandra* (Gyllin 1967) and also in common myna *Acridotheres tristis* (Sengupta 1982), it has been reported that roosting takes place earlier in the evening with overcast, stormy, misty or rainy weather than in the evenings with clear weather. Dense cloud cover and rains during mid-day, however, do not bring about premature returning of mynas to the roost. This has also been pointed out by Counsilman (1974) and Sengupta (1982) in mynas. Gyllin (1967) has reported that in corn bunting *Emberiza calandra*, the internal clock or internal rhythm may well be of primary importance affecting the time of roosting and the light intensity may only be of secondary importance. This may perhaps be applicable to our studies on Indian mynas.

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